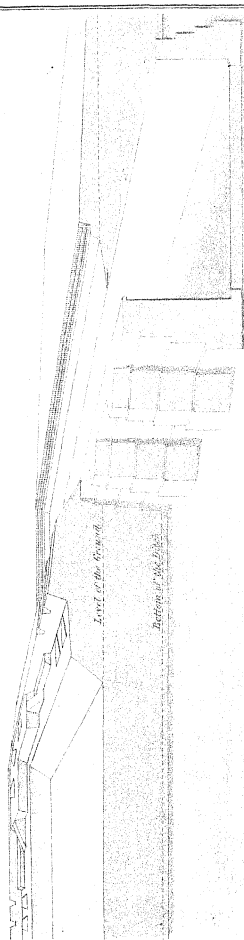


Showing the Countersloping Revetment and Counterforts with the Face of an empty Bastion Ditch & Covered Way.

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THE CONSTRUCTION
OF
THE MODERN SYSTEM,
CONSISTING OF
SIX DRAWINGS
AS EXECUTED AT SANDHURST AND ADDISCOMBE;
WITH
INSTRUCTIONS
GIVING THE DIMENSIONS OF EVERY LINE AND ANGLE.

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PREFACE.

NOTHING beyond plan drawing is attempted to be taught in this series of constructions ; it is intended as an introduction to works of higher pretensions, which omit most of the details given here. This being a series of first books will, it is hoped, justify numerous explanations, which might otherwise appear unnecessary and too trifling for insertion. Any error in this respect will not be thought a great grievance by many teachers.

Next to Vauban's First System, the most celebrated and best deserving of the young student's attention, is the Modern System. In this and the preceding volumes the construction of both systems is fully given. The series may probably be extended so as to include the several systems of permanent fortification, and the field works usually drawn at Sandhurst and Addiscombe.

In this volume the construction of all the parts of the Modern System is given in separate steps ; and, as far as practicable, a perfectly regular gradation is observed in the arrangement of the subject, beginning with the simple outline, and ending with the finished drawing containing every minute

detail. By this method it is expected that every difficulty will be more easily overcome, if not entirely removed.

The table of contents is purposely made copious, to be used as a syllabus of the subjects treated of in each chapter, by either pupil or teacher.

Many acknowledgements are due to F. Rumble, Esq., Lansdowne-Circus, Clapham Road, who kindly inspected early proofs of the plates.

HOLLAND HOUSE, LEE PARK, BLACKHEATH,
May 10th, 1852.

THE NEW REGULATIONS FOR THE ARMY.

MR. KIMBER has had considerable experience and success in preparing youths for the Military College and Schools, and is acquainted with all the recent regulations from the Horse Guards, respecting the examination of candidates for Commissions in Her Majesty's service, as well as those issued by the Directors of the Honourable East India Company, to candidates for direct appointments in their Army.

John A. Dugan
Analysis

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NOTICE.—As far as practicable, the unit (a yard or a foot) named in the scale attached to each plate and repeated at the head of each chapter, is the unit in which all the dimensions are given throughout the same plate and chapter.

In some of the plates where this is not the case, the following usual distinctions should be more particularly attended to:

Figures without any superscription stand for yards, one dash superscribed to a figure means feet, and two dashes mean inches. For instance, 3, 4', 5'', is read, 3 yards, 4 feet, 5 inches.

INTRODUCTION.

1. THE use of the ordinary stretching frame is too simple to require any explanation. A board or frame made of mahogany is better than one made of any commoner wood, because less liable to warp or crack.

A mahogany stretching frame, however, large enough for the purpose, may be generally considered too expensive, but a common clamped deal board with a little trouble will answer equally well. This board should be made 24 inches long by 18 inches, and about half an inch thick, free from cracks, and with a truly level surface. When a board either opens at the joints or becomes warped it is altogether unfit for use.

Whatman's stout imperial drawing paper is a convenient size and substance for military plan drawing. An entire sheet is the proper size for the following drawings on the scales indicated for each.

The right side of the paper is best for drawing upon, being somewhat smoother, it may be easily distinguished by looking at the maker's name, which reads correctly on the right side and is reversed on the wrong side.

To stretch the paper evenly a little care and experience are necessary. First damp both sides of the paper, and place the board in the middle of it; then cut a square from each corner, that the folds may be neater.

Apply paste to the margin which stretches beyond the board and fold it over tightly, taking care to secure the fold on each edge of the board with three or four drawing pins or small tacks, which may be removed when the paper is dry.

One end of the paper should be pinned on, then the *opposite* end, and afterwards the sides.

Both the ends and sides must be finished while the paper continues damp. Finally, lay the board down horizontally to dry, but in no case before a fire.

If no paste, glue, or drawing pins are at hand, sealing wax is, in expert hands, an excellent substitute.

2. In order to acquire a complete knowledge of the dimensions and relative positions of the parts of the simplest military work, it must be seen from three distinct points of view.

First, a bird's eye view must be obtained from some elevated position above the work, that its horizontal form may be perceived.

Secondly, a view in front and rear, that the elevation of the slopes may be seen in both positions.

To these must be added a third distinct kind of view, which is obtained by supposing the work to be cut by a vertical plane perpendicular to its crest.

These three views of different parts of the modern system are represented in the following plates, by three corresponding kinds of drawings.

I. A ground plan, more commonly called simply a plan, which is a horizontal section, and shews the length of the rampart and ditch, the width of the ditch, and thickness of the slopes.

II. Front and rear elevations, which represent the vertical height and respective positions of the different parts of the work, their form and proportions as seen from vertical planes in their front and rear.

III. A profile, or vertical section, which represents the height and thickness of the rampart and its subdivisions, and the width and depth of the ditch.

It must be well understood, however, that none of these drawings are exact representations of the works as seen from any one point of view, in which case they would be perspective drawings; but they are rather architectural or geometrical drawings, in which each part is seen as if projected perpendicularly from the work upon

a supposed plane, either upon a horizontal plane as in a plan, or upon a vertical plane in front or rear of the work as in an elevation, or upon a vertical plane intersecting the work at right angles, as in a profile.

3. It is usual to represent brickwork by red lines, and earthen work by black. In copying the following plates, the red lines should be drawn in with carmine, and the revetments and counter-forts are to have a light flat shade of the same colour, the counter-fort a little lighter than the revetment.

A dry ditch and the profiles of any work are to be coloured with a light flat shade of burnt sienna. Gamboge is used for all kinds of wood work.

In a shaded drawing, the light is generally made to fall from the upper left hand corner. All slopes facing the light are but slightly shaded, while those turned from it have a deeper shade.

The most prominent points of either a plan or elevation, or those points which stand most out towards the front of the drawing, are those on which the light shines most brightly, and from these points the shadows fall most distinctly and are the most sharply terminated. The more retired parts of the drawing have the strongest shades thrown round them, the edges of which are also less distinctly defined.

4. Fortification in theory, as developed in the systems of Vauban and the modern system, is strictly a science. Many of the assumptions, such as the perfectly horizontal plane upon which the systems are constructed, the accurate range of the arms employed in the defence, &c., are purely abstract and founded upon the principles of geometry. Again, the principle upon which the slopes of the different works vary according to the material of their composition and the superincumbent weight, the peculiar form of the revetment walls, and other similar matters, cannot be determined, nor can they be explained to the pupil, without the application of algebra.

In this view of the subject, fortification is as much a part of mixed mathematics as mechanics, optics, or any other branch of natural philosophy; and in this department, therefore, a non-professional may be quite as efficient as a professional instructor. At the same time it must be conceded, and the pupil should be made fully aware of the fact, that a knowledge of theory is only the groundwork upon which he must build *every thing* that will be practically valuable to him in his future career.

On the other hand, however, it may be asserted that the study of theory forms the best mental discipline that can be devised for the youthful military student, and is as nearly perfect as the most special system of training for any profession, the best of which fails to provide for every case which occurs in practice. "They are but a sort of parade exercise which cannot be made to include the means of meeting the thousand contingencies of actual service."

The application of science in the actual construction of fortifications, and the innumerable modifications of theory resulting therefrom, constitute the *art* of fortification. A knowledge of this art is best acquired by being actively employed in the construction of works, or by a careful study of existing fortresses, either from drawings and models, or by personal inspection and examination.

Colonel Jebb at the conclusion of his treatises upon attack and defence, emphatically remarks, that a much clearer idea of actual operations may be obtained by a few hours spent in the trenches annually executed at Chatham, than by description, or an extravagant consumption of midnight oil.

5. The great outlay required to reconstruct very extensive works, has generally prevented any material alteration in the tracing of old fortresses, and therefore, in most cases, only those modern improvements are introduced which do not interfere with the general outline.

The following calculation of the cost of the brickwork in one face of a bastion, will enable the student to ascertain, in a similar way, that of an entire front. This estimate will be a useful exercise, but

must only be regarded as an approximation to the actual cost. It is made for a plain wall, without casemates or galleries, and is about the lowest possible for any locality in this country, where materials are most abundant; but fortresses are often wanted in remote situations, and must be furnished with casemates, posterns, galleries, staircases, &c., which are the most expensive kinds of constructions, so that the actual cost is in some cases probably the double of that obtained by this method.

The length of the face of a bastion in the modern system is 360 feet, and by referring to Chapter III. the remaining dimensions required will be found.

	Feet.	Ft.	In.	Ft.	In.	Cubic Feet.
Revetment Wall	360 × 31	0 × 7	8			= 85560
Foundations ...	360 × 13	4 × 4	0			= 19200
20 Counterforts	35 × 7	8 × 4	8			= 25044
						<hr/> 129804 = 4807 cubic yds. <hr/>

The lowest price of brickwork may be stated at about 10s. per cubic yard, therefore, at that rate, the cost of brickwork of one face of a bastion will be

$$\frac{4807 \times 10}{20} = \text{£}2403.$$

Perhaps the best example of the modern system of fortification, and at the same time the most expensive, was the *dépôt* formed at Alessandria by order of Napoleon, from designs by Chasseloup de Laubat. A description of the construction of these works has recently been published by Col. J. S. Macaulay.

6. In the theory of fortification, the place to be fortified is first enclosed by equal right lines, forming the sides of a regular polygon.* The sides of this polygon are called *the exterior sides of the figure*, and the works constructed upon each of them are called *a front of*

* In speaking of the sides and angles of this supposed polygon, the word *figure* is often used instead of *polygon*.

fortification. The outlines and plans in the following plates contain two fronts.

Before the Modern System is drawn, the principal parts of the enceinte and outworks on a front of fortification should be quite familiar to the student. They are as follows :—

ENCEINTE.

I. The six lines used in tracing the enceinte.

- | | |
|---------------------|--------------------------|
| 1. Exterior side. | 4. Face of the bastion. |
| 2. Perpendicular. | 5. Flank of the bastion. |
| 3. Line of defence. | 6. Curtain. |

II. The principal Angles.

- | | |
|----------------------|--------------------------|
| Angle of the figure. | Curtain angle. |
| Flanked angle. | Angle of defence. |
| Diminished angle. | Angle of the tenaille. |
| Shoulder angle. | Interior flanking angle. |

OUTWORKS.

Named in the order of their construction.

- | | |
|----------------|-------------------------------|
| 1. Main ditch. | 4. Caponniere. |
| 2. Tenaille. | 5. Re-entering place of arms. |
| 3. Ravelin. | 6. Covered way. |

Besides the above, there are some other terms in use, the meaning and derivation of which are too obvious to require any explanation or reference to the plates.

The salient of the bastion. The faces of the tenaille. The curtain of tenaille. The salient of the ravelin. The re-entering angle of the counterscarp. The gorges of the ravelins and tenailles. The heads of the traverses. The head of a half caponniere. The crest and foot, or base, of a slope.

For a fuller detail of the technical terms referable to a front of fortification, and for further remarks on plan drawing, shading, and colouring, see "*Constructions of Vauban's First System.*"

7. In a supposed attack upon a front of the Modern System, the design of the arrangements is, to compel an enemy, in the first place, to attack and gain possession of the salient place of arms before the ravelin. He is then supposed to fight his way from one traverse to another, towards the re-entering places of arms, and thence to reduce simultaneously the ravelin and the redoubt in the re-entering place of arms, then the redoubt of the ravelin, and lastly to cross the main ditch opposite the face of the bastion. When he has done so, and gained possession of the two faces of the bastion beyond the coupures, there is a safe retreat provided for the defenders, by the angular staircases between the two parapets which join the faces of the cavalier and bastion. From behind these parapets the final effort at resistance must be made. The two guns placed in one parapet to defend the ditch of the cavalier, and the one in the other to rake the terre pleine in front of it, are the last means of defence provided for the besieged.

The covered way differs from Vauban's in three particulars.

I. The traverses in front of the ravelin are 9 feet thick, so that, while they are a protection against ricochet fire, they can easily be destroyed by the heavy guns of the enceinte, when it becomes necessary to prevent the enemy from taking shelter behind them.

II. The crest is *en cremaillere*, in order that, when the salient place of arms is taken, and the besieged are driven from behind the first traverse on each side, which will be immediately demolished, there may remain no protection against the fire from behind the next traverse in the rear. The same operations are designed to be repeated on losing the second and third traverse. Still further to strengthen the defence, the palisades behind each traverse are connected with the palisades of the covered way by a strong gate.

III. The re-entering place of arms has a command of 2 feet over the salient place of arms, the terre pleine of the former is $3\frac{1}{2}$ feet and that of the latter $1\frac{1}{2}$ feet above the level of the ground. This gives an advantage to the defenders, as the assailants must first enter the salient places of arms.

The re-entering place of arms has a circular crest to protect it from a ricochet fire. The sallyports are also curved for the same reason.

The redoubt in the re-entering place of arms has an elevation equal to that of the ravelin, and is furnished with a terre pleine that may serve for artillery. It strengthens very considerably the defence of the covered way, and renders the enemy's approach to the salient of the bastion impracticable. Its flank has a direct fire upon the salient of the ravelin. There is no flank on the opposite face, because the salient of the bastion is considered to be so well protected by other means that it cannot be attempted until the redoubt is taken. One ditch of the redoubt is flanked from the face of the ravelin, and the other is not defended from any part of the works, which is the most objectionable defect in the tracing of the Modern System. When the redoubt is no longer tenable, the safe retreat of its defenders is secured by the staircases in the rear. The construction of these staircases being such that no shot can reach them from any part of the covered way in front of the ravelin.

It is in the ravelin, however, that there is the most important distinction between the Modern System and that of Vauban. The ravelin in the Modern System is much larger and more salient. By its increased magnitude, space is obtained for a strongly revetted redoubt within it; and by its saliency, it effectually protects the bastion from attack until the ravelin itself is taken. Its faces are provided with coupures, which aid in annoying the enemy when in possession of the ravelin, by bringing a flanking fire upon the terre pleine. These coupures also protect the redoubt, in the re-entering place of arms. The redoubt of the ravelin adds another formidable obstacle to the enemy. Its casemented flanks bring a powerful fire against an enemy who should attempt a breach in the face of the bastion before taking the redoubt. The ditch of the redoubt is defended from the faces of the bastion, the faces of the redoubt being drawn towards the shoulder angle of the crest for that purpose. The gorge being parallel to the curtain, the staircases in the rear of

the redoubt cannot be seen from any part of the covered way, and the defenders of the ravelin can thus withdraw without being observed, while in Vauban's System, the staircases in the gorge of the ravelin are exposed to the enemy's fire from the covered way.

In Vauban's First System the ditches are all upon the same level, but the ditches of the Modern System are not, as will be seen from the profiles, plate 3. The main ditch is 6 feet deeper than the ditch of the ravelin, which arrangement preserves the gorge of the ravelin from an attack by surprise, and covers the beseiged in passing from the re-entering place of arms and salient before the bastion, after the enemy has obtained possession of the salient before the ravelin.

The difference in the revetments and counterforts, between Vauban's and the Modern System, is pointed out in the remarks at the end of Chapter III.

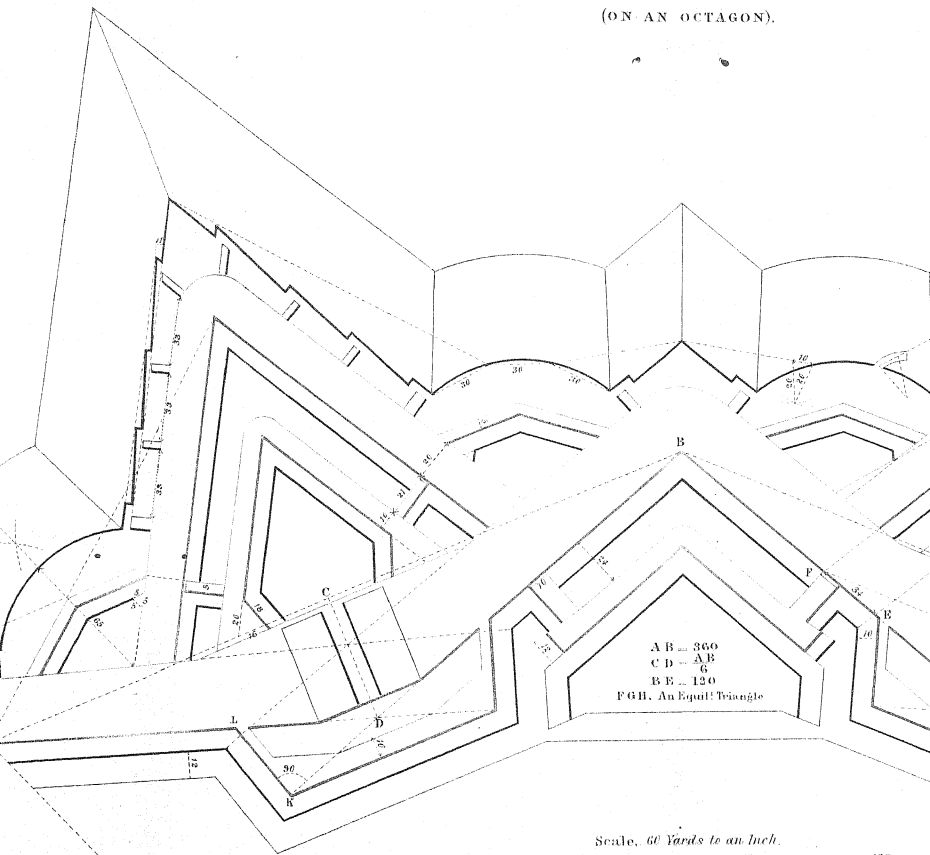
The points of difference in the enceinte are not so important as those named above, and are also too evident to require any special notice.

8. As the angle of the figure increases, the salients of the ravelin become more prominent. On any smaller angle than that of an octagon, the advantage of this arrangement is not fully obtained. The figures, therefore, on which the Modern System is generally drawn are, an octagon, a decagon, and a duodecagon.

Having fixed upon a figure, the next step to be taken in drawing an outline or plan, is to determine the angle. This angle may be found by Euclid, book 1, prop. 32, cor. 1, or by the following formula, a very simple deduction from Euclid's corollary.

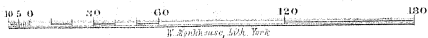
$$\text{The required angle} = 180^\circ - \frac{360^\circ}{\text{No. of sides in the fig.}}$$

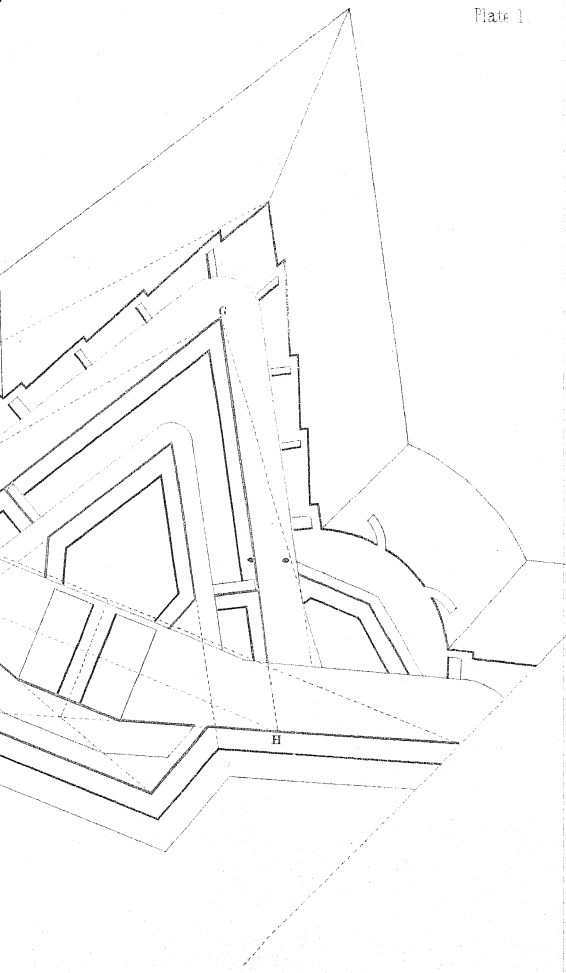
OUTLINE OF THE MODERN SYSTEM. (ON AN OCTAGON).

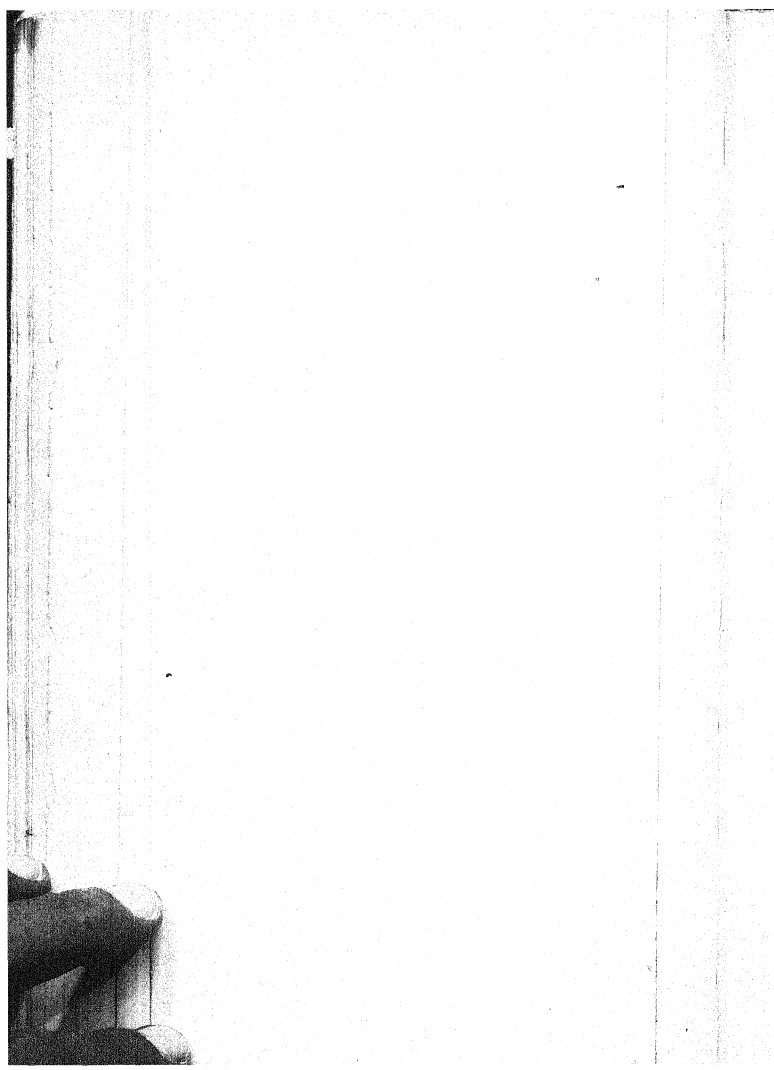


$AB = 360$
 $CD = AB$
 $BE = 120$
 FGH , An Equil! Triangle

Scale, 60 Yards to an Inch.







CHAPTER I.

CONSTRUCTION OF THE OUTLINE OF TWO FRONTS ON AN OCTAGON, AS DRAWN IN PLATE I.

SCALE TO BE USED IN THE COPY, 30 YARDS TO AN INCH.

CAUTIONS.

1. *First trace all the lines in pencil, then draw the red, and lastly the black lines.*
2. *Draw each line in the order in which it is here given.*
3. *The only letters of reference to be inserted in the copy are, A, B, C, D, E, F, G, H.*

ENCEINTE.

9. *The angle of the figure is $180^\circ - \frac{360^\circ}{8} = 135^\circ$.*

It is thus laid down :—First draw a perpendicular line through the centre of the paper ; this line will form the capital of the central bastion in the drawing. Take a point in this line (B in the plate) about two-thirds of the distance from the bottom, and from this point draw downwards two lines of indefinite length, each making an angle of $67\frac{1}{2}$ degrees with the perpendicular. These two angles together form the angle of the figure, with its apex pointing upwards.

10. *The six lines used in the construction of the enceinte.*

1. *The exterior sides.* Make each of them 360 yards long, measured off from the apex of the angle just found, and along the lines last drawn.

2. *The perpendiculars.* Draw each, 60 yards long, from the centres of the exterior sides towards the centre of the figure.


3. *The lines of defence.* On each front draw lines from the extremities of the exterior side, through the extremity of the perpendicular on the same front, and let these lines be continued towards the capitals of the opposite bastions.

4. *The faces of each bastion.* Measure off 120 yards from the angles of the figure, along each line of defence.

5. *The flanks.* Let fall from the extremity of each face, perpendiculars to the lines of defence on the same front.

6. *The curtain.* Join the inner extremities of the flanks on the same front.

This completes the magistral line of the enceinte. The crest line must now be drawn, parallel to the magistral and 10 yards within it. The capitals of the two half bastions on the extreme right and left of the drawing may also be traced, by means of a protractor. These should be drawn in the same way, and making the same angle with the exterior sides, $67\frac{1}{2}$ degrees, as the capital first drawn makes with the exterior sides meeting it.

 On this tracing we may observe that—

1. The length of the exterior side is made 300 yards, the same as in Vauban's First System, and for the same reason, viz.—in order that the longest line of fire from the enceinte may not exceed the ordinary range of the arms employed in the defence. The longest line of fire from any part of the enceinte to the crest of the opposite glacis is, from the flanks along the main ditch to the salient of the covered way in front of the opposite bastion. The line of defence (B K) is 250 yards, to which add the width of the main ditch at the salient of the bastion, 30 yards, and the width of the covered way, 10 yards, so that the longest line of fire in the Modern System is 290 yards, a distance within the range of common muskets.

2. The distance between any salient and the shoulder of the opposite bastion (B L) is nearly the same as the line of defence (B K), which is about 250 yards, and the distance from the shoulder (L) to the salient of the same bastion is 120 yards, the length of the face. The distance between two salients, therefore, measured along

two lines drawn between salient, shoulder, and salient, (A L B in the plate,) is 370 yards.

The straight line drawn from salient to salient, on the exterior side, must necessarily be somewhat less, and consequently 360 yards is taken as the nearest round number, the difference of a yard or two in this particular being insignificant.

3. The perpendicular is always the same length, one-sixth of the exterior side, so that the dimensions of all the lines and nearly all the angles, on a front of the Modern System, are the same for all figures.

11. THE CAVALIER.

The cordon. Trace the cordon parallel to the faces of the bastion, and 34 yards within them.

The ditch. Make it 10 yards wide, rounded opposite the salient.

The crest. On the faces trace the crest, 10 yards from the cordon and parallel to it, and on the flanks, 34 yards from the flanks of the bastion and parallel to them.

The flanks. Trace the base of the exterior slope on the flanks, 10 yards from the crest, and make it 28 yards long.

THE COUPURES.

The ditch. Draw the counterscarp perpendicular to each face of the bastion, from points where the produced faces of the ravelin meet it.

Trace the cordon of the escarp parallel to the counterscarp, and 10 yards apart from it.

The crest. Make it 7 yards from the cordon.

THE TRAVERSES IN REAR OF THE COUPURES.

The cordon. Make it perpendicular to the face of the cavalier, and 8 yards in rear of the cordon of the coupure.

The crest. Make it 7 yards in rear of the cordon, and 12 yards long.

A line drawn from the outer extremity of this crest, towards the corner of the adjacent counterscarp of the coupure, determines the respective lengths of these two short parapets.

By this arrangement the angular staircase between them cannot be seen from the *terre pleine* in front, and it thus affords a safe retreat, when the enemy has gained possession of that part of the bastion.

OUTWORKS.

12. *The six outworks, in the order of their construction.*

I. MAIN DITCH. To trace the main ditch—

1. Take a radius of 30 yards, and with the salients of each bastion as centres, describe arcs.

2. Draw tangents to these arcs, towards the shoulder angle made by the crest of the parapet of the opposite bastion.

II. *TENAILLE.* *The faces.* These are already drawn, being those parts of the lines of defence which meet at the inner extremities of the perpendiculars.

The counterscarp. Parallel to the faces, and 16 yards in the rear, draw the counterscarp.


The curtain. Draw a parallel to the curtain of the enceinte, at a distance of 10 yards from it, for the counterscarp of the curtain, and 16 yards in front of it draw the cordon.

Trous de tenaille. Cut off each extremity of the tenaille by a parallel to the adjacent flank of the bastion, drawn 5 yards from it. Each opening thus formed is called the *trou de tenaille*, or gap of tenaille.

III. *RAVELIN.* The ravelin and the redoubt in the ravelin may be considered two separate works, each defended by a ditch in front.

The faces. Mark off 34 yards from the shoulder angle, along the face of each bastion, and join by a right line the points thus marked off on the faces of the opposite bastions. On the exterior side of this line, as a base, construct an equilateral triangle, (Euclid, book 1, prob. 1.) Those parts of the two sides of this triangle which are cut off by the counterscarp of the main ditch, form the faces of the ravelin.

The ditch. Parallel to the faces draw the counterscarp of the ditch, which make 20 yards wide, and rounded off in front of the salients.

 *The construction of the faces of the ravelin by means of an equilateral triangle, is shewn on the left front of the plate.*

THE REDOUBT IN THE RAVELIN.

The faces. Draw them parallel to the faces of the ravelin, and towards the shoulder angle of the crest of the bastion.

The ditch. Make the ditch 10 yards wide, and rounded at the top similar to the ditch of the ravelin.

The gorge. Bisect equally the remaining thickness of the ravelin at its extremities in the rear, and join the points of bisection; this line forms the gorge of the redoubt.

The flanks. At the points where the faces and gorge meet, mark off on each face 20 yards, and on each gorge 16 yards; the right lines joining these points form the flanks, 18 yards long.

IV. THE CAPONNIERE.

The crest. Draw a line on each side of the perpendicular, parallel to it, and 6 yards from it.

The glacis. Draw the foot of the glacis parallel to the crest, at a distance of 20 yards.

The head. Trace the head of each half caponniere parallel to the adjacent counterscarp of the main ditch, at a distance of 9 feet.

V. RE-ENTERING PLACE OF ARMS. We shall make three divisions in the construction of this work:—1. Crest. 2. Sally-ports. 3. Redoubt. *N.B. The sally-ports and the redoubt cannot be drawn until the width of the covered way is traced. Vide, The glacis, page 17.*

1. *The crest.* With a radius of 65 yards, and the re-entering angle of the counterscarp as a centre, describe the crest.

2. THE SALLYPORTS. 1. Divide the crest of the re-entering place of arms into three equal parts, or draw within it three chords, each 30 yards long.


2. Draw the two lines of direction from these points of division, one to the salient of the covered way in front of the bastion, and the other to the salient of the covered way in front of the ravelin.

3. On these lines mark off 10 yards from the crest.

4. Make the extremities of this length two centres, from which, with a radius of 20 yards, draw two arcs inwards to intersect.

5. From the intersection of these arcs describe concentric arcs 3 yards apart, one arc with a radius of 20 yards, and the other 17 yards.

6. At the point where the outer arc intersects the line of direction, cut off the two arcs by a line drawn towards their centre.

 The first of these six steps is shown by the dotted lines on the extreme left of the outline, and the rest in succession, in the re-entering places of arms towards the right.

No rule exists for the exact position of the sallyports; the crest is sometimes divided into four spaces, and the sallyports placed wider apart, as in plates 2 and 4. They are made to curve either way indifferently.

3. THE REDOUBT IN THE RE-ENTERING PLACE OF ARMS.


The capital. Bisect the re-entering angle of the counterscarp, (Euclid, book 1, prop. 9.)

The ditch, faces, and crest. Draw a right line between the salients of the bastion and ravelin, and the part of this line cut off by the counterscarp and capital forms the counterscarp of one face of the redoubt. The counterscarp of the other face is formed by drawing a line from the intersection of the capital and counterscarp just drawn, towards the salient of the crest of the covered way in front of the bastion. Within each counterscarp draw the faces, at the distance of 5 yards. Within the faces trace the crest at the distance of 8 yards.

The flank. Measure off 5 yards on the crest adjoining the counterscarp of the ravelin, and from the same point take the same

length along the counterscarp of the ravelin. Join these two points, and the flank, 5 yards long, is obtained.

The gorge. A line produced through the extremity of the flank, from the salient of the cordon of the ravelin, gives the demigorge on one side; the remaining demigorge is part of the counterscarp of the main ditch, as already drawn.

 This construction is shown on the right front of the outline.

VI. COVERED WAY.

The glacis. First mark out the width of the covered way, 10 yards, by lines drawn parallel to the counterscarp of the ditches, and trace the foot of the glacis by parallels to these lines, drawn 50 yards distant from them.

The traverses. These are 10 yards long, the width of the covered way. In an outline, the superior slope only is marked by the crest line and exterior side, these lines shew the thickness of the traverse.

The traverses at the entrance of the re-entering places of arms are 6 yards thick, all the others are 3 yards thick. On each branch of the covered way, opposite the ravelin, there are four traverses.

First construct the traverses at the re-entering places of arms. From the extremities of the crest of the re-entering places of arms, draw their crests perpendicular to the counterscarp.

Then draw the traverses at the salient places of arms, placed so that their exterior sides coincide with the produced faces of the bastions and ravelins.

Between the traverses at the re-entering and salient places of arms, there is an interval of 105 yards, from which subtract 6 yards, the space occupied by the two intermediate traverses; and one-third of the remainder, or 33 yards, gives the space between each traverse.


The crest en cremaillere. The passage along the covered way round the head of each traverse is *en cremaillere*, and must be drawn as follows :—

1. Draw parallels to the heads of the traverses, 11 feet from them.

2. Sixteen feet from the exterior side of each traverse, and parallel to it, draw short lines cutting the parallels last named.

3. Draw the crest lines of the covered way diagonally between each traverse.

4. Cut off a triangular space from the head of each traverse, to make it parallel to the crest line.

 These four steps are shown by dotted lines, on the left side of the outline.

NOTE.

At the salients of the bastions, at the salients of the ravelins, and at the salient places of arms, the crest lines are thus modified. In each case, the crest is cut off by a line drawn perpendicular to the capital, and made 6 yards long, to obtain a direct fire from the work. Junior pupils may omit this in the outline, but the change must always be made in copying plate 2.

13. Principal lineal and angular dimensions on a front of the Modern System.

The angle of the figure varies according to the number of sides in the figure, as follows:—

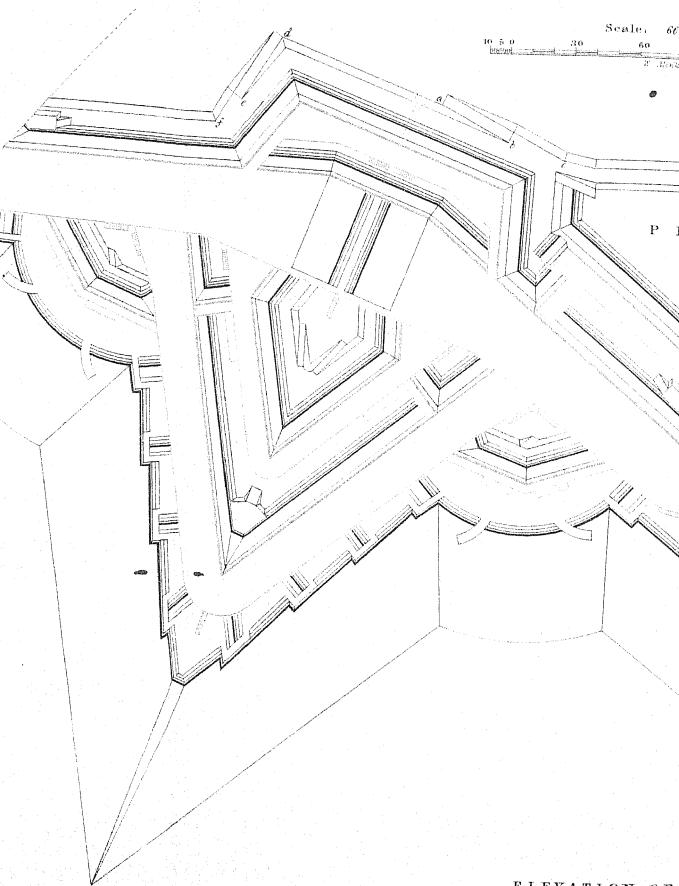
No. of sides	...	8	.	9	.	10	.	11	.	12
Angle of figure		135°	.	140°	.	144°	.	147 $\frac{1}{2}$ °	.	150°

The following lines and angles are the same for all figures:—

1. Exterior side	...	...	...	...	...	360	Yards
2. Perpendicular	...	...	...	...	...	60	"
3. Line of defence	...	...	...	...	...	250	"
4. Face of the bastion	...	...	...	...	...	120	"
5. Flank	...	...	...	...	...	42	"
6. Curtain	...	...	...	...	...	105	"
Flanked angle	...	...	...	...	...	98°	
Shoulder angle	...	...	...	...	...	127°	
Curtain angle	...	...	...	...	...	108°	
Angle of defence	...	...	...	...	...	90°	

T H E M O D E L
(on an

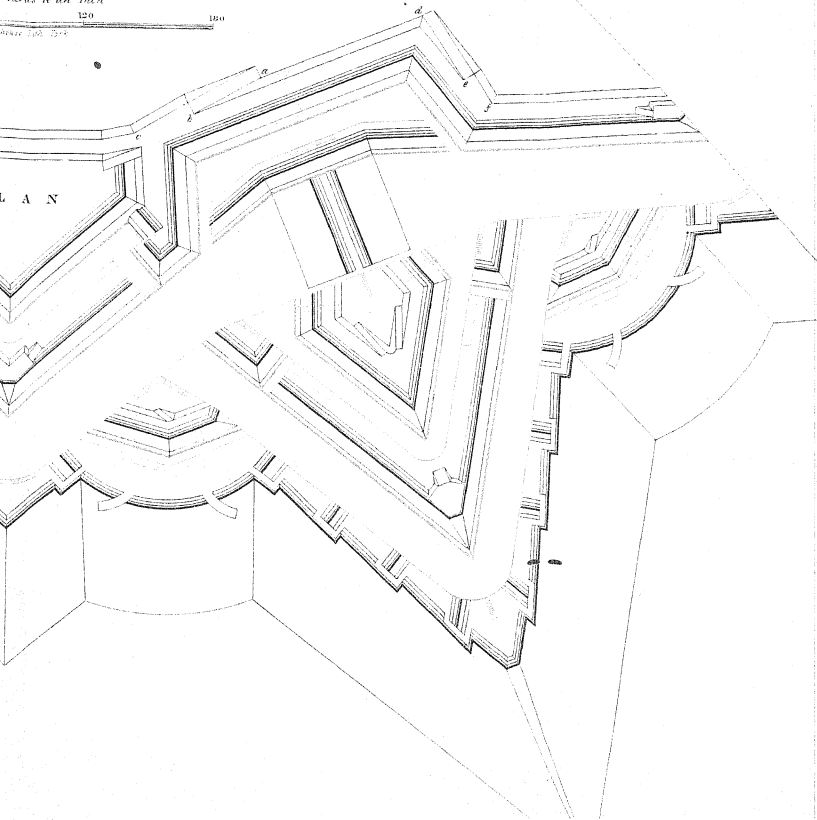
Scale, 60



ELEVATION OF

ERN SYSTEM
(a Octagon.)

Yards to an Inch



THE ENCEINTE.

CHAPTER II.

CONSTRUCTION OF THE PLAN AND ELEVATION OF TWO FRONTS, ON AN OCTAGON, AS DRAWN IN PLATE II.

SCALE TO BE USED IN THE COPY, 30 YARDS TO AN INCH.

CAUTIONS.

1. *First trace all the lines in pencil, then draw the red lines, and lastly the black lines.*
2. *Draw each line in the order in which it is here given.*

PLAN OF THE ENCEINTE AND OUTWORKS, WITH BARBETTES AND COMMUNICATIONS.

14. *The outline* should first be completed in pencil, according to the instructions for constructing the outline, plate 1. The only difference between the outline in plate 1 and the outline in plate 2 is in position. In the latter the apex of the exterior angle points downwards, in the former it points upwards. This difference may be made at the beginning of the drawing; or the outline may be finished precisely as described for plate 1, and the slopes added as given below. In the latter case the drawing must be inverted when the plan is finished, that the elevation may be added a proper distance below the foot of the glacis.

THE SLOPES.

15. These must be added to the outline, by drawing parallels to the cordons or crests of the respective works, at the widths given in the following tables. The horizontal width of any slope as measured on a plane, is called the base of that slope, because it is

the base of a right angled triangle, the perpendicular to which base gives the height of the slope. The base of each slope in the plan of the enceinte and outworks is as follows:

ENCEINTE.

16. *Enceinte and Cavalier.*

Exterior slope	4 Yards
Superior do.	6 "
Interior do.	$\frac{1}{2}$ "
Step of banquette	$1\frac{1}{2}$ "
Slope of do.	2 "

17. *The coupures in the faces of the bastion, and the traverses in rear of the coupures.*

Exterior slope	2 Yards
Superior do.	5 "
Interior do.	$\frac{1}{2}$ "
Step of banquette	$1\frac{1}{2}$ "
Slope of do.	2 "

The terre pleine of the enceinte is 8 yards broad, except in rear of the cavalier, and the slope of the terre pleine is $4\frac{2}{3}$ yards.

N.B.—The terre pleine behind the cavalier must be omitted, until the ramps at the gorge of the bastion and the cavalier ramps are drawn.

OUTWORKS.

18. *Tenaille, ravelin, redoubt within the ravelin, and redoubt within the re-entering place of arms.*

Exterior slope	2 Yards
Superior do.	6 "
Interior do.	$\frac{1}{2}$ "
Step of banquette	$1\frac{1}{2}$ "
Slope of do.	2 "

Besides these slopes, the *redoubt within the ravelin* has also the

Terre pleine	.. .. .	6 Yards
Slope of do.	.. .. .	4 "

and the *redoubt within the re-entering place of arms* has the

Terre pleine	.. .. .	4 Yards
Slope of do.	.. .. .	3 "

The *coupures in the ravelins* have the same slopes as those in the faces of the bastion.

19. *Caponniere, covered way, and traverses in the covered way.*

Interior slope	.. .. .	$\frac{1}{2}$ Yard
Step of banquette	.. .. .	$1\frac{2}{3}$ "
Slope of do.	.. .. .	2 "

The exterior slope of the traverses is $1\frac{2}{3}$ yards.

20. BARBETTES.

The barbette in the bastion.

1. Mark off 20 yards upon the crest, on each side of the salient.
2. From these points draw perpendiculars 8 yards long, the width of the barbette.
3. From the extremities of these perpendiculars draw parallels to the crest, to meet and form a salient angle, as in the copy.
4. Make the ramps 8 yards long and 3 yards wide, of the same form and in the same position as given in the plate.
5. Add the slope to the barbette, $1\frac{1}{2}$ yards wide.

The barbette in the ravelin.

1. On each side of the salient mark off upon the crest 20 yards.
2. From these points draw perpendiculars 8 yards long.
3. Join the extremities of these perpendiculars.
4. On this last line form the ramp, 8 yards long and 5 yards broad, in the same form as the one drawn in the plate.
5. Add the slope, $1\frac{1}{2}$ yards wide, as in the plate.

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21. COMMUNICATIONS.

These are ramps, staircases, and posterns.

RAMPS.

22. *The cavalier ramps*, leading from the terre pleine of the cavalier to the terre pleine of the enceinte, are 20 yards long and 4 yards broad, and are drawn parallel to the curtain of the enceinte.

(Having drawn these ramps, now add the slope in rear of the cavalier, and the terre pleine of the enceinte, with its slope, in rear of the cavalier, which were before omitted.)

2. The slope in rear of the cavalier is 2 yards broad.

2. The terre pleine of the enceinte is here only 6 or 7 yards broad, and is the same width as far as the cavalier ramps extend.)

23. *The ramps at the gorge of the bastion.*

Side. On the base of the slope of the terre pleine, mark off, from the centre of the curtain, 12 yards, and from this point draw a right line (*a b* in plate) 36 yards long, to the top of the slope.

Top and bottom. Draw inwards, at each extremity of this side, perpendiculars 6 yards long.

Side. Join the ends of these perpendiculars.

To obtain the direction of the slope of the terre pleine above each ramp, produce the side just drawn upwards to (*c* in the plate) the corresponding line in rear of the cavalier.

24. *The ramps in the flank of the bastion.*

1. *Side.* Draw a right line 36 yards long, (*d e* in plate,) from the curtain angle and from the base to the top of the interior slope of the rampart.

2. *Top and bottom.* Draw inwards, at each extremity of this line, perpendiculars 6 yards long.

3. *Side.* Join the ends of these perpendiculars.

To trace the interior slope of the rampart along the flank, produce this last side upwards to (*f* in plate) the corresponding line running parallel to the face of the bastion.

The ramp from the ditch of the coupure, in the face of the bastion.
Length 12, width 5 yards.

25. *The ramps within the redoubt of the ravelin.*

Side. Mark off upon the top of the slope 10 yards from the salient angle, and from this point draw a right line 20 yards long, to meet the base of the slope.

Top and bottom. Draw inwards, at each end of this line, perpendiculars 4 yards long.

Side. Join the extremities of these perpendiculars.

The required arcs are drawn from the intersection of the tops of the two ramps produced.

26. *The ramps of the ravelin.* The ramp from the ditch of each coupure to the terre pleine of the ravelin, is 24 yards long and 4 yards wide.

The ramp within the redoubt of the re-entering place of arms. Length 8 yards, width 4 yards.

The ramps in the re-entering place of arms, leading from the ditch of the redoubt to the terre pleine, are 15 yards long and 3 yards broad. At the foot of each is a space 2 yards wide. The top of each ramp is 3 yards from the salient of the counterscarp.


STAIRCASES.

27. *The angular staircases,* from the ditch of the cavalier to the terre pleine of the bastion, are made 1 yard wide, and about 6 yards long on each side of the angle.

The double staircase in the redoubt of the re-entering place of arms. 12 yards long, 2 yards wide, with a space at the bottom formed by cutting off 3 yards from each side of the re-entering angle.

The staircase within the salient place of arms. The staircase within the redoubt of the ravelin. Make each of them 12 yards long and 2 yards wide.

28. *The staircase from the ditch of the redoubt in the ravelin, to the retrenchment behind the coupure.* 10 yards long, 2 yards wide, with a space at the foot at least 2 yards square.

29.  Rule to determine length of staircases.

Each step should be 12 inches wide, and not more than 7 inches high.

Let us apply these dimensions to ascertain the lengths of the staircases leading from the covered way into the main ditch, at the re-entering and at the salient places of arms, and also those from the redoubt in the ravelin into the main ditch. In all these cases the height of the wall is 7 yards, or 252 inches. Since each step is to be 7 inches high,

$$\frac{252}{7} \text{ or } 36 \text{ is the number of steps required.}$$

Each step is to be 1 foot wide; therefore the horizontal length of a staircase of 36 steps will be 36 feet, or 12 yards, which is the length given to these staircases in the plan.

POSTERNS.

30. The posterns are all made 2 yards wide, with a retaining wall marked on the interior slope of the rampart as in the plate.

NOTE.

We advise the young student to finish the plan before he begins the elevation. Let the red and black lines, the title, and scale, be all inked in, and the plan thoroughly cleaned with bread and Indian rubber; then paste to the edges of the board a sheet of thin tissue paper, tightly stretched over the paper, and covering every part except that required for the elevation. Every part of the plan will be seen through the tissue paper, and the lines required for the construction of the elevation can be traced upon the tissue paper without touching the drawing itself.

FRONT ELEVATION OF THE ENCEINTE AND TWO TENAILLES.

31. *Explanation of the Drawing.*

This drawing gives the elevation from the bottom of the ditch, upon a supposed vertical plane in front of the bastion, and at

right angles to its capital. From this plane only the superior and exterior slopes, and the escarp revetments can be seen, and to shew them only four horizontal lines are required,—the crest and base lines of the superior slope, and the cordon and base of the escarp wall.

The vertical heights of the cordon above the bottom of the ditch, and the widths of the exterior and superior slopes, are the same as given in the profiles, plate 3.

Construction.

32. The horizontal dimensions of the works shewn in the elevation are obtained by drawing parallels to the capital of the bastion between corresponding lines in the plan and elevation, *i. e.*, from the crest line in the plan to the crest line in the elevation, or from the cordon in the plan to the cordon in the elevation. A large T square is the best instrument for laying down points in the elevation by means of parallels to the capital of the bastion. With this instrument every required point may be obtained without actually drawing any lines.

Enceinte.

33. Vertical dimensions.

Base line. Produce the capital of the bastion downwards, and draw a perpendicular to it, to represent the base line of the revetment wall.

Escarp, exterior and superior slopes. Draw three parallels to the base line, above it and at the respective distances of 10, 14, and 15 yards. The intervening spaces represent the escarp, and the exterior and superior slopes.

34. Horizontal dimensions.

Escarp. Determine the extremities of each face of the bastion, the curtain, and the faces of the two half bastions, by drawing from these points in the cordon of the plan imaginary perpendiculars to the cordon in the elevation, or more simply,—take points in the

cordon of the elevation perpendicular to the extremities of these works in the cordon of the plan. Drop perpendiculars from the points obtained in this way to the base of the revetment.

Exterior and superior slopes. These are obtained in the same way as the escarp, by means of the crest and base lines of the superior slope. From every angular point made by these lines in the plan, determine the corresponding points in the elevation. Right lines joining the adjacent points found in this way, complete the tracing of the enceinte.

The Cavalier.

35. *Vertical dimensions.* Above the bastion in the centre of the elevation draw two parallels to the crest, at the respective distances of 2 and 3 yards.

36. *Horizontal dimensions.* Determine the extremities of the two faces, by perpendiculars from the faces on the plan, as was done for the enceinte.

The Tenaile.

37. *Vertical dimensions.* Draw parallels to the base of the revetment wall, at the respective distances of 6, 8, and 9 yards from it. The intervening spaces represent the escarp, and the exterior and superior slopes.

38. *Horizontal dimensions.* Determine the length of each face, and complete the slopes by perpendiculars from the tenaille in the plan.

Postern. Take perpendiculars from the postern in the tenaille of the plan, to determine the position of the postern in the elevation, and draw the postern.

The Caponniere.

39. The caponniere is not represented in the elevation, only its position.

40. *Horizontal dimensions.* Determine the position of the banquette, crest, and foot of the glacis, by drawing perpendiculars from these points in the faces of the tenaille of the plan.

41. *Vertical dimensions.* Make the crest $2\frac{1}{2}$ yards, and the banquette 1 yard from the ground.

Plate 3.

B A S T I O N

REDOUBT IN R. P. A.

COVER'D WAY

Glacis

GROUND PLAN OF REVELEMENTS AND COUNTER-FORTS.

C U R T A I N

T E N A I L L E

REDOUBT IN RAVELIN

R. A V E L I N

C O V ' D W.

GROUND PLAN OF REVETMENTS AND COUNTERFORTS.

Scale, 40 Feet to an Inch.

CHAPTER III.

CONSTRUCTION OF THE PROFILES AND PLANS OF THE REVTMENTS AND COUNTERFORTS, AS DRAWN IN PLATE 3.

SCALE TO BE USED IN THE COPY, 20 FEET TO AN INCH.

CAUTIONS.

1. *Trace all the lines in pencil, before inking in any of them.*
2. *Finish all the colouring before drawing the thick red lines.*
3. *The figures enclosed in brackets are not to be inserted in the copy.*

PROFILES.

42. *Lines of defilade and site.* Draw the line of site horizontally from side to side, and above it trace the line of defilade for the cavalier, parallel to it and 31 feet apart from it.

43. *Horizontal dimensions.* 1. Begin on the left, and mark off towards the right, on the line of defilade, the width of every slope as far as the crest of the bastion, from the dimensions in the plate. Drop perpendiculars from these points to the line of site.

2. Above the line of site draw the line of defilade for the bastion, and upon it mark off the horizontal dimensions as before, as far as the crest of the redoubt in the re-entering place of arms, and upon it drop perpendiculars as before to the ground line.

3. Above the line of site draw the line of defilade for the redoubt in the re-entering place of arms, and upon it proceed as before to the crest of the covered way.

44. *Vertical dimensions.* Beginning again on the left, mark off on the perpendiculars the distance of the top of each slope from the

Counter-arched revetments. This term is applied to revetments which have their counterforts connected in both or either of the following methods. Neither plan is introduced as forming part of the revetment of the Modern System, but as among the most approved that have been proposed for strengthening revetments of any kind.

1. When the nearest sides of the adjacent counterforts are connected by arches, two between each counterfort, one above the other. These arches, by being either slightly connected with the revetment wall or altogether disconnected from it, will support the rampart and parapet, when the revetment wall itself has been destroyed by artillery.

2. When the adjacent tails of each counterfort are connected by an arched wall, built vertically with its convex surface towards the rampart. By this means the lateral pressure against the revetment wall is very considerably diminished. *Vide* article Revetment, Penny Cyclopædia.

With respect to the execution of this drawing, it is the easiest in the book, and we expect that the youngest student will have no difficulty in making a correct copy of the plate. It may, however, be necessary to explain the meaning of the numbers enclosed in brackets on the plate. These numbers are given to the student *as the most convenient* for him to take, but they are no part of the construction.

All the profiles in plate 3, are sections across any portion of the ramparts shewn in plan on plate 2, taken vertically and at right angles with the crest. Sections taken in this way, through the crest of the enceinte, cannot always be continued across the ditch so as to cut the counterscarp at right angles. In cases where this cannot be done, the proper width of the ditch is not shewn, and this is indicated on the plate by enclosing the inaccurate dimension within brackets.

Similarly no vertical section cutting the gorge of the ravelin at right angles, when produced will cut the face also at right angles; and therefore the interior of the ravelin, which is shewn in the profile is not any fixed width, but varies according to the supposed positions of the sections across the gorge and face.

Scales, 40 Yards to an Inch.

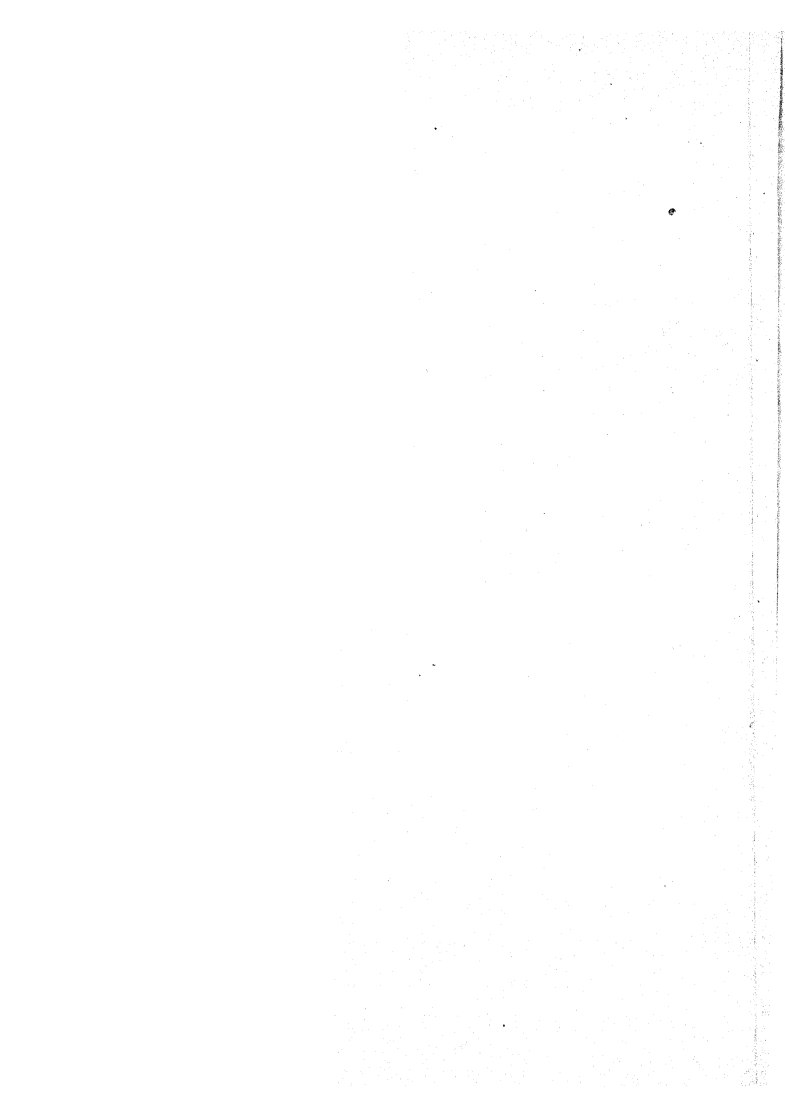
10 5 0 10 20 30 40 80 120

W. H. HARRISON, Sole Proprietor.

ONE FRONT OF THE
MODERN SYSTEM.

Scale, 40 Yards to an Inch.
W. H. Woodman, Esq., Eng.

Plate 4.



CHAPTER IV.

CONSTRUCTION OF THE PLAN OF ONE FRONT ON A DECAGON, WITH EMBRASURES AND PLATFORMS, AS DRAWN IN PLATE IV.

SCALE TO BE USED IN THE COPY, 25 YARDS TO AN INCH.

CAUTIONS.

1. *Draw each line in the order here given.*
2. *The crest lines and the cordons should not be drawn their full depth until all the shading is finished.*

ENCEINTE.

50. First draw the *six lines*, as follows :—

1. *The exterior side.* Draw a horizontal line 360 yards long, about one-fourth of the distance from the bottom of the paper.
2. *The perpendicular.* Drop the perpendicular from the centre of the exterior side, and make it 60 yards long.
3. *The lines of defence.* From the extremities of the exterior side, through the extremity of the perpendicular, draw the lines of defence.
4. *The face of each half-bastion.* Measure each off 120 yards.
5. *The flanks.* Let fall from the extremity of each face, a perpendicular to the line of defence.
6. *The curtain.* Join the inner extremities of the flanks.

51. Before proceeding with the outworks—1. Draw the capital of each half bastion, at an angle of 72° with the exterior side.

2. Trace the crest line of the enceinte parallel to the cordon, and 10 yards within it.

OUTWORKS.

52. Every particular for the construction of these is given in article 12.

53. *The slopes, barbette, batteries, and communications.*

These are to be next drawn, as given in articles 15—30.

The embrasures and platforms.

54. *Explanation of terms.* The inner extremity of an embrasure is called the *neck*, the outer opening the *mouth*, the sides are called *cheeks*, and the lower surface or bottom is called the *sole*. That part of the parapet which is between every two embrasures is called a *merlon*, and the part under each embrasure is called the *genouillere*.

In this plate, the simplest form, or rather outline of the embrasures is given. The sole only is represented, the cheeks are not drawn, but the sides of each sole which is nearest the light, and which is therefore shaded by the adjoining cheek, is marked by a thick line. The sides of the platforms opposite the light, from which shadows fall, are similarly distinguished.

The axis of an embrasure is an imaginary horizontal line passing through its centre, from the neck to the mouth. This axis is always in the same direction as the line of fire, which is generally *direct*, that is, perpendicular to the crest of the parapet.

55. It is better to draw all the axes first, and afterwards to mark out the dimensions of the embrasures and platforms from them. *The axes should never be less than 6 yards apart.*

56. *The axes in the flank of each half-bastion.* Take points on the crest 7 yards from each extremity, and divide the distance between these two points into 5 spaces of 6 yards each. Six points will be thus obtained, through which draw the axes parallel to the line of defence.

57. *Axes of the embrasures on the face of each half bastion.*

1. First produce the faces of the ravelin and the redoubt in the ravelin, in pencil, to meet the crest on the face of each half bastion,

2. From a point two yards distant from the produced face of the redoubt, and towards the salient, take a space of 6 yards, and through the two points thus obtained draw parallels to the produced face, for the axes of the two embrasures, the guns in which flank the ditch of the redoubt.

3. From a point 1 yard distant from the produced face of the ravelin, and towards the salient, take three spaces of 6 yards each, and through the four points thus obtained draw parallels to the produced face, for the axes of the four embrasures, the guns in which flank the ditch of the ravelin.

58. *Axes in each face of the ravelin.* From the perpendicular of the barbette at the salient, mark off upon the crest line ten spaces of 6 yards each. Through each alternate pair of points thus obtained, beginning with the first pair, draw the axes perpendicular to the crest; the two pairs of points remaining indicate the positions of the two block traverses.

59. *The block traverses.* These are not subject to direct fire, and are therefore made only 4 instead of 6 yards thick, and 7 yards long. The slopes of these traverses vary in width, from (that of their height) 4 yards to (one-fourth of their height) 2 yards. The two on the face of each half bastion are placed as in the plate, one exactly between the guns which flank the ditches of the redoubt, of the ravelin and the ravelin, and one between the latter guns and the foot of the ramp of the barbette at the salient. The two traverses on each face of the ravelin are in the positions pointed out above.

60. The axes being all drawn, trace the embrasures and platforms.

The sole of an embrasure is commonly about $7\frac{1}{2}$ yards in length. At the mouth it extends 1 yard beyond the superior slope, at the neck about half the width of the interior slope. The yard on the exterior slope must always be marked out, but the interior slope cannot easily be bisected on a less scale than that of 30 yards to an inch.

The width of an embrasure at the mouth is half the thickness of the parapet, generally 3 yards, and at the neck 1 yard or 2 feet.

61. *Horizontal dimensions of the embrasures and platforms.*

1. *Embrasures.*

Extremity of the mouth on the exterior slope ..	Yards. 1
Ditto neck on the interior slope ..	$\frac{1}{3}$
Width at the mouth	3
Ditto neck	1

2. *Platforms.*

Length.. .. .	Yards. 5
Greatest width	$4\frac{2}{3}$
Least width.. .. .	3

62. In the construction of the embrasures and platforms from the dimensions above, proceed as follows:

1. *Embrasures.*

1. Draw parallels on the exterior slopes to mark the extremity of the mouth of each embrasure.

2. Draw similar parallels upon the interior slope, to mark the extremity of the neck of each embrasure.

3. Mark the width of each mouth by taking a point $4\frac{1}{2}$ feet on each side of the axis.

4. Mark the width of each neck, by taking a point $\frac{1}{2}$ yard on each side of the axis.

5. Join the two points (3 and 4) which are on the same side of the axis, by a right line which will form the sole of the embrasure as in the plate.


2. *Platforms.*

1. Take a point upon the axis 5 yards from the base of the interior slope, and through this point draw a line parallel to the interior slope.

2. Upon this line take $2\frac{1}{8}$ yards on both sides of each axis, which will mark out the widest part of the platforms.

3. Mark off the least width, by taking a length of $1\frac{1}{2}$ yards on both sides of each axis.

4. Join the two points (2 and 3) which are on the same side of each axis.

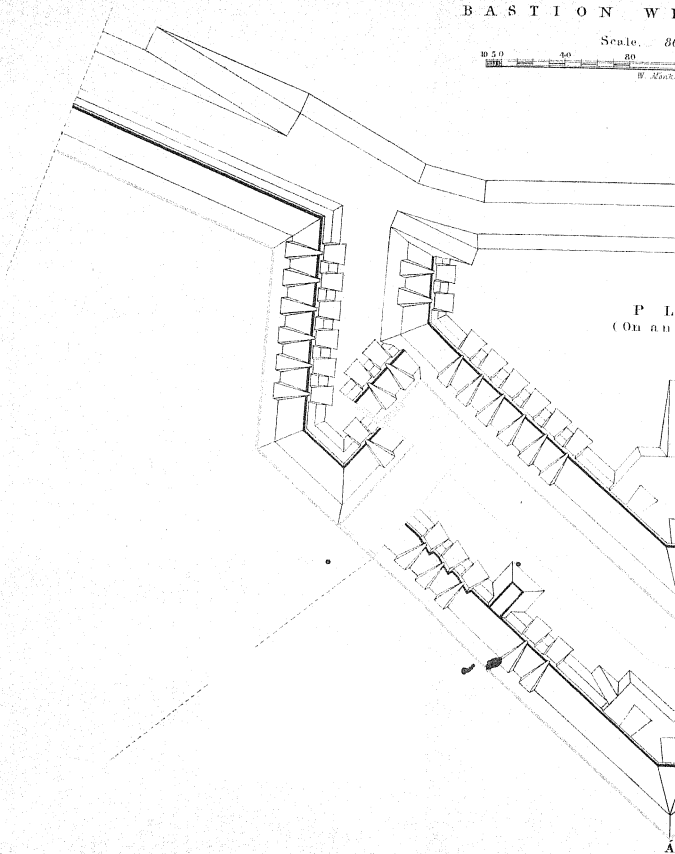
 The palisades should be added last, after all the lines are drawn in ink and the shading is finished, with great care, close to the base of the interior slope. The printing of the plate is defective in this particular.

BASTION WORK

Scale. 80



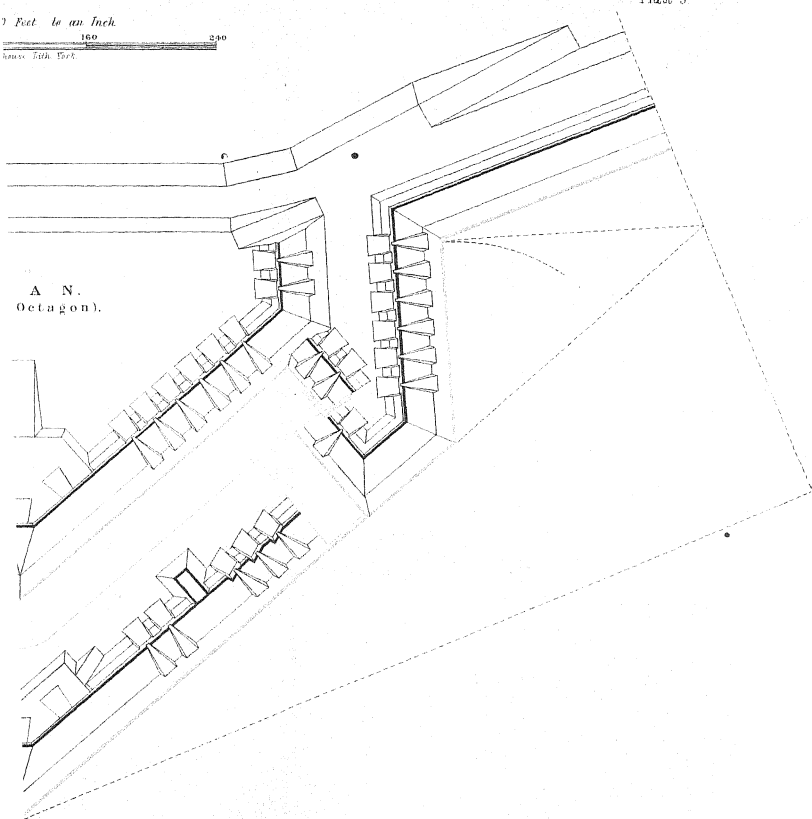
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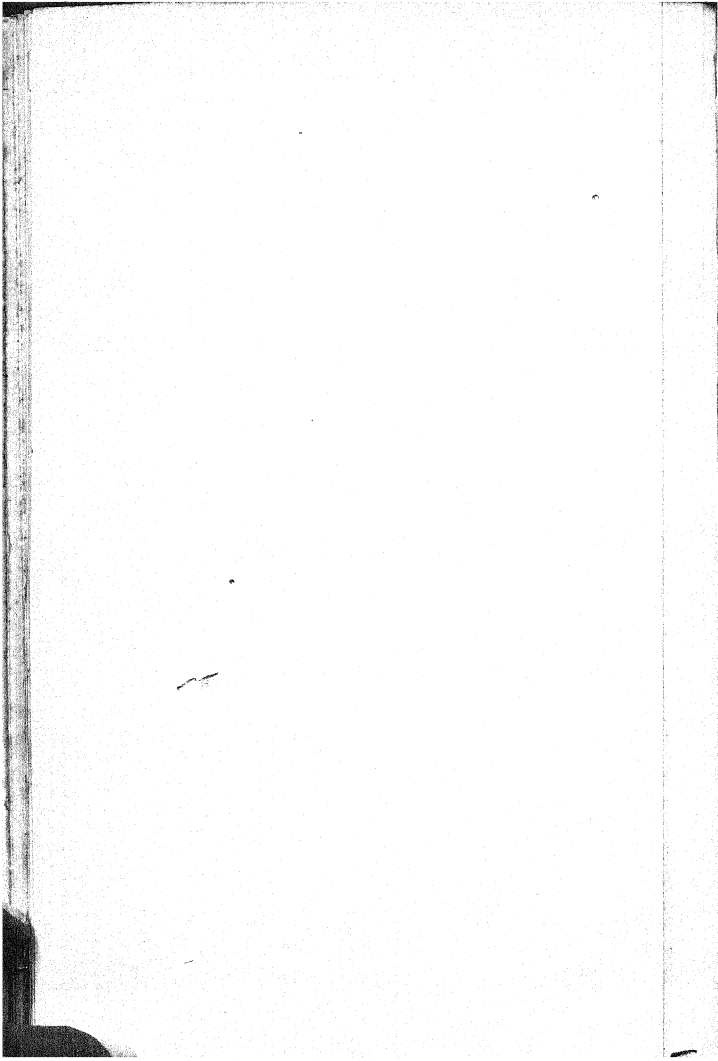


7 Feet to an Inch

160 240
House Fifth Fort

A N.
Octagon).





CHAPTER V.

CONSTRUCTION OF THE PLAN AND ELEVATION, ON A DUODECAGON, OF A BASTION, WITH CAVALIER AND BARBETTES, AS DRAWN IN PLATE V.

SCALE TO BE USED IN THE COPY, 40 FEET TO AN INCH.

PLAN OF THE BASTION WITH CAVALIER.

63. The salient, shoulder, and curtain angles, and the lengths of the faces and flanks are given in article 13. The outline of the bastion may be described with these dimensions and the slopes added as given for the enceinte, articles 16 and 17.

This method is not so correct as that given for the construction of plate 1, but it is more convenient.

64. If the sheet of paper is large enough, (the size recommended in the introduction,) the outline of the plan should be laid out in a similar way to that described for plate 1, thus:

Angle of the figure. 1. Draw a perpendicular through the centre of the paper.

2. From a point in this line, and on each side of it, draw right lines at an angle of 75° . The two angles together form the angle of the figure, 150° , with its apex turned downwards.

Exterior sides. Measure off from the apex of this angle, and on each of these lines, 180 yards, one-half of the exterior side.

Perpendiculars. At the extremities of these half exterior sides, draw inwards perpendiculars 60 yards long.

Lines of defence. Draw the lines of defence by joining the apex of the exterior angle and the extremities of the perpendiculars.

Faces. Make each of the faces of the bastion 120 yards long.

Flanks. 1. With the extremity of each face as a centre, and 42 yards as a radius, describe arcs within the lines of defence.

2. From the inner extremity of each perpendicular draw tangents to these arcs.

3. Perpendiculars to these tangents drawn from the extremity of each face give the flanks.

The curtain. Produce the perpendicular inwards. The curtain is a line drawn from the inner extremity of the flank, at right angles to the produced part of the perpendicular.

65. This completes the outline of the bastion.* The slopes should now be added, the dimensions of which are given, articles 16 and 17.

66. *The barbette in the salient of the bastion* is to be drawn in the next place, as described in Chapter II., article 20.

67. *The barbette in the cavalier.* 1. On each side of the salient mark off 20 yards.

2. From these points draw perpendiculars 10 yards long.

3. Join the extremities of these perpendiculars by a right line.

4. In the middle of this line mark off the top of the ramp 6 yards, and perpendicular to it trace the sides 16 yards long.

The salients of the cavalier and bastion are to be modified as before described, in the note after article 12, page 18.

68. In the next place, trace the lines of defence and the produced faces of the ravelin very lightly, so as to be easily rubbed out after the embrasures are put in.

69. The line of fire, as has been observed, is generally direct; sometimes, however, it is oblique, as in the four guns on each face

* The cavalier and coupures are to be added according to the directions in article 11.

of this bastion. In both cases the dimensions of the embrasures and platforms, as given below, ought to be set out perpendicular to the axis. Where the embrasures are cut obliquely, the crest line is not straight but serrated, as represented in the plate.*

70. *The axes in the flanks of the bastion.* Take points on the crest 7 yards from each extremity, and divide the distance between these two points into five equal spaces of 6 yards each. Six points will be thus obtained, through which draw the axes parallel to the line of defence.

71. *Axes of the embrasures on the face.* From a point 4 yards distant from the produced faces of the ravelin, and towards the salient, mark off six spaces of 6 yards each, and through the first three points thus obtained draw parallels to the produced face of the ravelin, for the axes of the three embrasures, the guns in which flank the ditch of the ravelin.

The next two points marked off point out the position for the block traverse, 4 yards thick and 7 or 8 yards long.

Through the last two points thus marked off, draw perpendiculars to the crest, for the axes of the two guns which have a direct fire from the face.

72. *The axes of the embrasures in the cavalier.* The elevation of this work is sufficient to protect it from a ricochet fire, so that here no traverses are placed between the guns.

On each face, and at an equal distance from the shoulder angle and the barbette, draw seven parallels 6 yards apart, perpendicular to the crest.

In the middle of each flank take a distance of 6 yards, and through the two points which mark this space draw perpendiculars to the crest.

* In Plate 4 the oblique embrasures were not set out perpendicular to the axes, and the crest and platforms were therefore less correctly drawn, which was done for the sake of being easier to be copied.

73. The axes being thus laid down, draw the embrasures and platforms according to the dimensions below.

The cheeks of an embrasure decline outwards from the neck to the mouth. At the neck they are either vertical or have a declination of 1 foot: if vertical at the neck, they have a declination of 1 foot at the mouth; and if they decline 1 foot at the neck, a declination of $1\frac{1}{2}$ feet is given them at the mouth. The declination of the neck cannot be shewn in a drawing on a less scale than 30 yards to an inch.

74. *Horizontal dimensions in feet of the embrasures and platforms on the plan.*

1. *Embrasures.*

Soles.	Extremity of the mouth on the exterior slope	3
	Ditto of the neck on the interior slope ..	1
	Width of the mouth	9
	Ditto at the neck.	2 or 3
Cheeks.	Declination at the neck	0 or 1
	Ditto at the mouth	1 or $1\frac{1}{2}$

2. *Platforms.*

Length.. .. .	15
Greatest width	14
Least width.. .. .	9

75. In the construction of the embrasures and platforms from the dimensions above proceed as follows:—

1. *Embrasures.*

Soles. 1. Draw the parallels on the exterior slopes to mark the extremity of the mouth of each embrasure.

2. In a drawing upon a large scale draw similar parallels on the interior slopes to mark the extremity of the neck of each embrasure. In a drawing upon a small scale omit this dimension.

3. Mark the width of each mouth by taking a point $4\frac{1}{2}$ feet on each side of the axis.

4. Mark the width of each neck by taking a point 1 or $1\frac{1}{2}$ feet on each side of the axis, and join these two points by a right line, which will form the base of each cheek.

Cheeks. From each base line mark off the declination of each cheek by points taken at the mouth and neck, and join these points by a right line, which will form the top of each cheek.

Finally, join the extremities of the top and base lines at the mouth and cheek of each embrasure.

2. Platforms.

1. Mark along the axis the length.

2. Mark off the greatest width by a line perpendicular to the axis, extending 7 feet on each side of it.

3. Mark off the least width by a line perpendicular to the axis, extending $4\frac{1}{2}$ feet on each side of it.

THE ELEVATION.

76. The elevation here is drawn in precisely the same way as that in plate 2, the construction of which is given, articles 33—36, to which reference must be made.

Embrasures in the elevation.

77. In this elevation only the mouth and part of the cheek of each embrasure can be seen. Their construction is as follows:

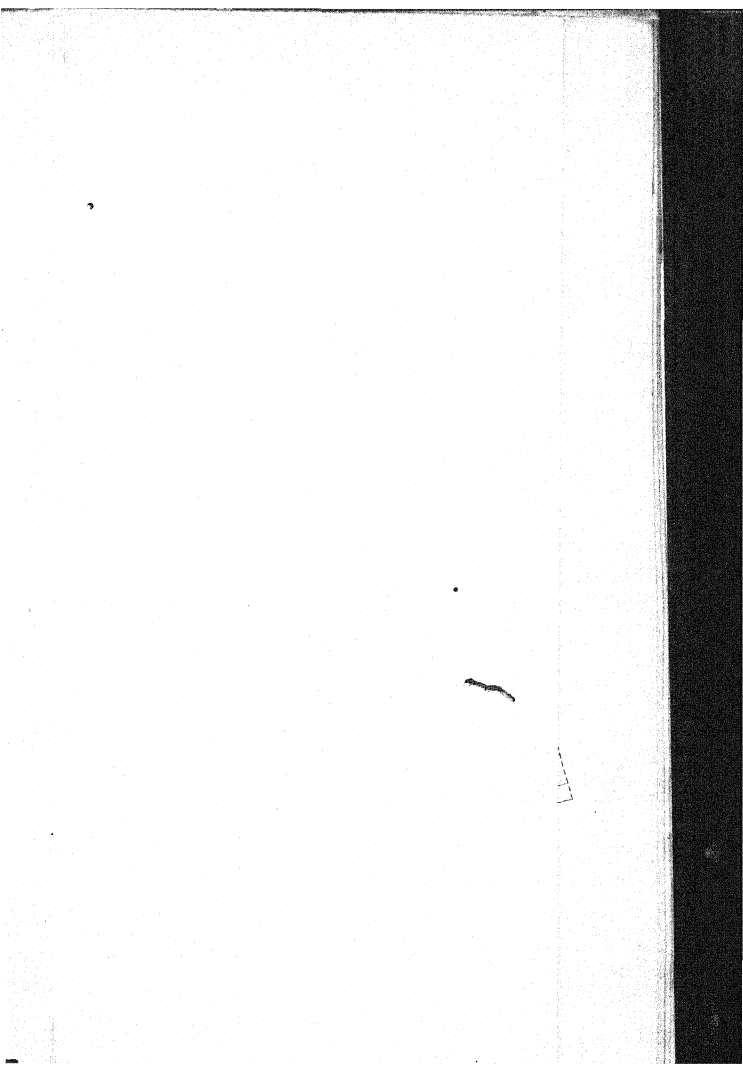
1. *Base line of the mouth.* Draw horizontal lines 3 feet below the superior slope, in the elevation, on the faces of the bastion and cavalier.

2. *Soles.* From the extremities of the mouth of each embrasure in the plan, draw, or imagine, two perpendiculars to the base line just drawn. The intersections of these perpendiculars with the base line mark the width of each mouth in the elevation.

3. *Cheeks.* To mark their declination, drop, or suppose, perpendiculars from the upper corner at the mouth of each cheek in the plan, to the base line of the superior slope in the elevation. Join these points with the extremities of the soles, in the same way as the corresponding points are joined in the plan.

4. From the neck of each embrasure in the plan let fall two perpendiculars to the crest in the elevation. Join each point thus found with the upper corner at the mouth of the same cheek.

5. There only remains to be drawn, as in the plate, the very small portion of the interior slope seen at the neck of each embrasure.



PLAN
OF
ONE FRONT
OF
THE MODERN SYSTEM.

Scale.— 35 Yards to an Inch.

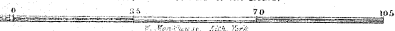
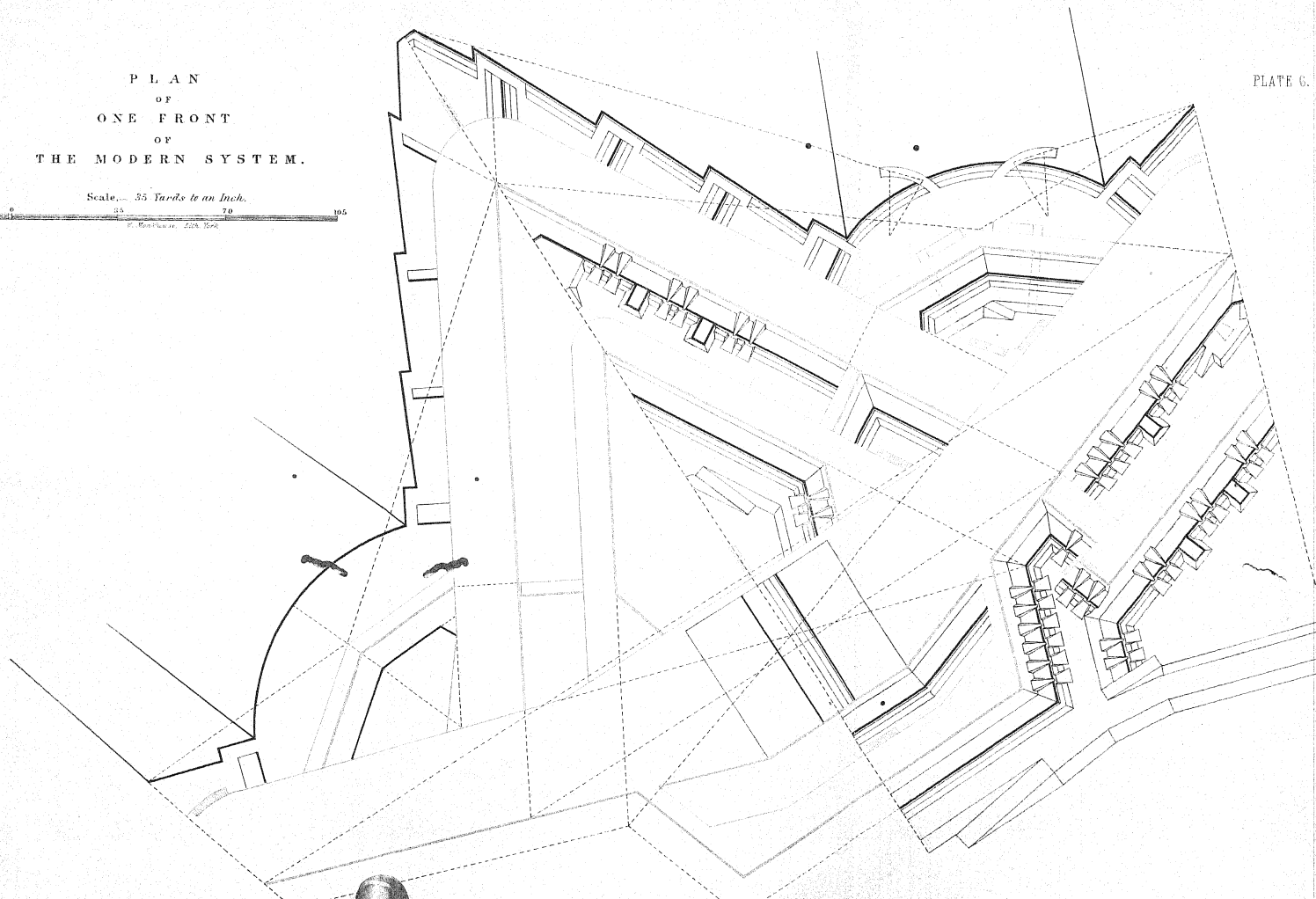


PLATE C.



CHAPTER VI.

A SYNOPTIC COMBINATION OF PLATES I., II., IV., AND V., IN ONE DRAWING.

REMARKS UPON THE PRECEDING PLATES, AND EXPLANATION OF PLATE VI.

78. The previous plates, except No. 3, are all initiatory, and recommended as exercises to young students, in order that by frequent repetition the construction of every part may be thoroughly learned.

In the preceding chapters, the construction of all the parts of the Modern System is given in separate and regular steps. The plates also present the same series of gradations, carefully arranged according to the complexity of the subject. This point has been kept in view more particularly in drawing the embrasures and platforms, because youths so generally fail with respect to them. The insertion of the embrasures and platforms on a small scale is a very difficult feat, even for a practised hand, and in most cases is never attempted.

Plate 4 presents the style in which they are usually drawn, on a scale of 30 yards to an inch. The soles only are shewn, while the thick line on one side represents the shade from the cheek nearest the light. The platforms are drawn obliquely where the embrasures are oblique; this plan saves a good deal of trouble, looks quite as well as when they are drawn absolutely correct, as in plate 5. The shadow from each platform is shewn by a thick black line.

Plate 5 is intended to be copied upon a much larger scale than plate 4, and therefore accuracy in every respect is more easily attained.

Plate 6 presents the greatest difficulty in the book, the embrasures and platforms being drawn strictly correct, and on a small scale. This plate is in fact given principally as a specimen of very accurate drawing upon a small scale. A slight comparison of it with the previous plates will suffice to shew that all the details necessary for its construction have been already given.

It is intended as a copy for one of two fronts to be drawn similarly to those in plate 2.

CONSTRUCTION.

SCALE TO BE USED, 30 YARDS TO AN INCH.


79. PLAN.

1. From plate 2 make an exact copy in pencil of the plan, with the exception of the half-front on the extreme right, which must be left in outline, as in plate 6.

2. From plate 6 trace, in pencil, the embrasures, platforms, and block traverses, on the right half-front and left front of the drawing. Assistance will be required from plate 4 for placing the guns on the face of the empty half bastion, on the extreme left of the drawing.

3. Trace the red and black lines in the whole of the two fronts.

4. Colour the ditch and shade the slopes in the left front of the plan, from plate 4.

 If the elevation be not added, the title will now be printed and the scale drawn in the same position as in plate 1. The elevation is not often inserted, it is more ornamental than useful, and its correct execution takes up a considerable time. The shading and colouring are more difficult than the shading and colouring of a plan, and when properly finished are much more frequently the master's work than that of the pupil.

If the elevation be added, the shading in plate 4 will be incorrect as a copy, because the plan must be supposed to be inverted.

80. ELEVATION.

1. Having adopted the precaution recommended in the note, page 24, trace in pencil the elevation from plate 2.

2. From plate 5 trace, in pencil, the embrasures in the bastion. The embrasures in the face of the half-bastion on the left must be drawn without a copy. They should be constructed from the plan in the same way as the rest, but as they are seen sideways, they present a somewhat different appearance. This deduction is left to the ingenuity of the student.

3. Trace the red and black lines in the whole of the two fronts, like those in the elevation, plate 2, and the embrasures like those in plate 5.

4. Colour and shade the left front from the elevation in plate 5. The half-bastion on the left being a considerable distance from the front of the drawing should be thrown into a strong shade, and the bastion in the centre should have the brightest light upon it; being the most prominent part of the picture.*

5. Finally, print the title and draw the scale in the same position as in plate 2.

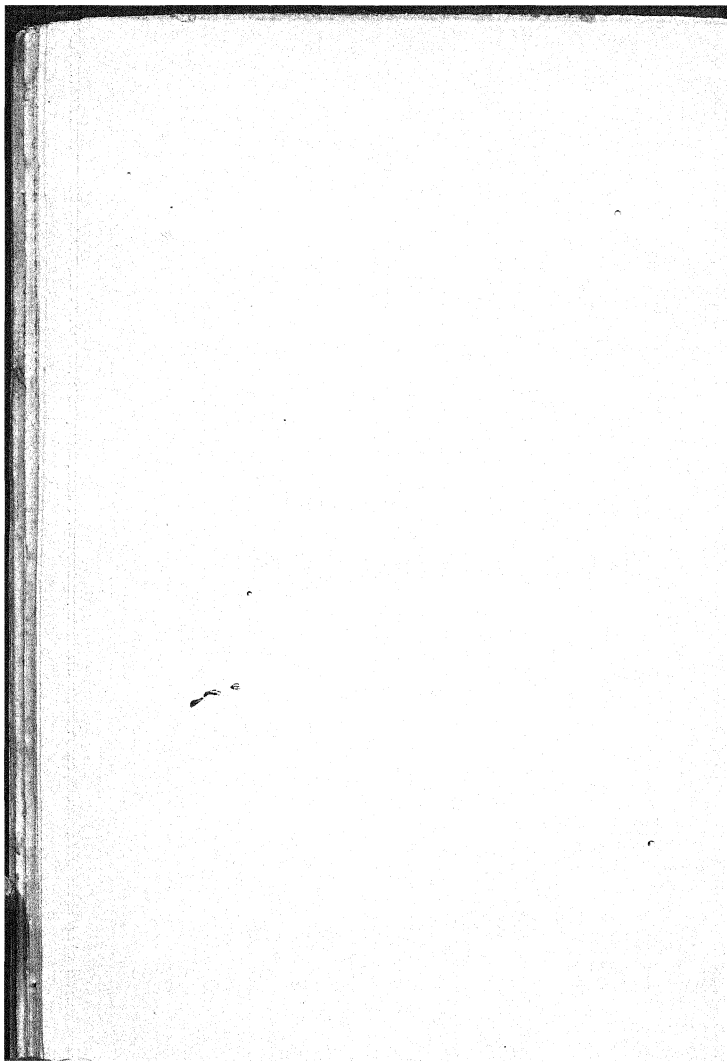
81. The drawing of the plan and elevation from plate 6, when completed as recommended, is an evident combination of plates 1, 2, 4, and 5. It exhibits at one view the three following distinct stages in the construction :

1. The outline of the half-front on the extreme right of the drawing.

2. The finished drawing on the remaining half of the same front.

3. The shaded and coloured drawing of the whole front on the left of the drawing.

* In the appendix to Vauban's First System, price 1s. 6d., an exact copy is given for the elevation and plan in this position, both for the drawing of the embrasures and the shading of the whole front.



BY THE SAME AUTHOR.

CONSTRUCTION
OF
VAUBAN'S FIRST SYSTEM,

CONSISTING OF SIX DRAWINGS AS EXECUTED AT SANDHURST
AND ADDISCOMBE. *Price Five Shillings.*

OPINIONS OF THE WORK.

"We have had frequent reason to condemn the practice of Civilians in teaching and writing upon subjects purely and essentially military. We have the country deluged with Clergymen undertaking to prepare youths for the higher branches of the service. We have the military instruction departments in our inferior public-proprietary schools and colleges filled by a set of men who never smelt the odour of gunpowder, much less practically studied its powers and variations, who could not tell you the distinction between the angle of dispar and the angle of elevation, or would not know a "sponge" from a "pricker," or that if you placed a dozen of them in an open country to lay down the lines of a fortification, would not know which way to turn or what to do.

"Of as much use would be the knowledge that these gentlemen, lay and clerical, convey, and which is *collected by a moderate dipping* into Straith, Macauley, Malortie, Landmann, or Muller, &c.—excellent works as they all are—a *theoretical study* would be to the man who, placed in a vessel in the middle of the Atlantic, supplied with compass, sextant, chronometers, and charts, and all the other appurtenances necessary for a thorough navigator, were told to find his way back to the point from whence he started. We will tell you, reader, how some of these *military tuition* affairs are got up—very much in the style described by the dissipated gentleman in the play of *Used Up*. A gentleman reads a little—very mildly, from one or two of the works we have mentioned—talks a little, advertises a little, and finally knows very little—everything by little, except perhaps the last-but-one-mentioned requisite; but we can add one more, but not a "little," for it is a "great deal," viz., *assurance*, an amount of which commodity is imbibed equal to the biquadrate power of all the rest together!

"With few exceptions, and very few they are, it requires a military man, thoroughly and practically, as well as theoretically versed in the sciences of his profession, to properly prepare youths for the higher walks of the Service.

"We have carefully examined Mr. Kimber's little work, and we have no hesitation in believing the author to be a glorious exception to the above stricture. Works of this class have so long been wanting, that the faults and deficiencies of a fresh book treating on a subject invaluable to the military student, must be many and glaring for us to *unconditionally condemn* it. There are circumstances which justify a slight departure from the established rules of rigorous criticism; and when a profession—the noblest amongst the highest—is in want of and demands the descriptive and strong aid of literature to illustrative, explain, and develop the sciences which are its essentials, even the critic can well afford to waive some of the strictness and severities of his office. But Mr. Kimber's little work is in no such want of quarter, it does not require in the review of it mercy to be mingled with justice; it can firmly stand upon its own ground and safely challenge the usefulness and merits of *many* of its predecessors.

"The title page which we have copied at the head of this article sufficiently explains the purpose of this little work; and the clearness in which it is written, the practical but simple development of its parts, and the mass of data collected in its pages, more than carry out the promise of its modest title."

British Army Despatch, April 18, 1851.

"I do not know how Messrs. Parker and Co. became aware that I recommended your book, but I have done so to all those who I knew were preparing for commissions in the army, as to them I consider it a most valuable assistance, the instructions and drawings in it being both clear and comprehensive, and given in such a simple form that the student can easily obtain the information he requires."

CAPTAIN A. R. SAVAGE, R. M. Arty.,
Instructor in Fortification,
Royal Naval College, PORTSMOUTH.

"THE want of such a work as Mr. Kimber has now published has long been felt, not only by teachers, but by students instructing themselves in their barrack rooms, quietly and most creditably gaining for themselves that knowledge they did not obtain from masters in their younger years. This *little* work will go very far to supply the want of *oral* instruction, and to give the careful learner those minute but most necessary details which will enable him to construct Vanban's First System, and prepare him for the further pursuit of the interesting study of fortification."—*Naval and Military Gazette, April 20, 1851.*

"THIS is a work which we can strongly recommend to all those who wish to obtain an easy introduction to the elements of fortification, both for its apparent accuracy, and also for the neatness and elegance of the plates, consisting of six coloured plates of the outlines and details, with copious explanations and directions for the drawing, colouring, &c., of Vauban's First System."

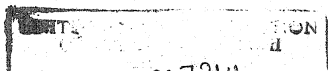
Educational Times, May 18, 1851.

"MILITARY FORTIFICATIONS.—A small but very interesting work on this subject has recently been published. The author, T. Kimber, Esq., B.A., is a gentleman well known in this city, and the highest military authorities have been pleased to speak in commendation of the work, as most valuable not only to teachers but also to students instructing themselves in their barrack-rooms. It gives the careful learner those minute but most necessary details, which will enable him to construct Vauban's First System, and prepare him for the further pursuit of the interesting study of fortification. The work is illustrated with beautifully executed working drawings (lithographed, we believe, by Monkhouse, of York.) The *Naval and Military Gazette* gives a flattering notice of the work, which instructs the student, from the very first step, how to determine the angle of the figure on which the plan is to be traced, and how to complete the magistral line of the *enceinte*. It next proceeds to the outworks, and clearly recapitulates all the lines and angles on a front of fortification as given in plate 1. The plan, profile, and geometric elevation of embrasures, is given in plate 2, with admirable instructions for the drawing of every line in its right order. The re-entering place of arms and circular staircases in the front of a bastion, are clearly drawn in plate 3. The fourth plate gives a full bastion, with a Barbette battery in detail. In the fifth plate we have Vauban's First System on a hexagon, with the dotted lines of construction retained, for the information of the learner. The profiles are represented in plate 6, and the letter-press affords every information and explanation. The work concludes with some useful instructions on drawing, shading, and colouring of plans, which may be perused with advantage by civilians as well as military students."

Yorkshire Gazette, May 24th, 1851.

"DEAR SIR—I have just purchased your excellent monograph on "Vauban," and am delighted with it; it seems to me to exhaust the subject as far as regards delineation and affording facility to the self-instructor."

FREDERICK SMITHE, High Road, Lee, Blackheath.





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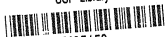
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